

“Microscopic Effects of Stress on Platinum.” By THOMAS ANDREWS, F.R.S., F.C.S., and CHARLES REGINALD ANDREWS.
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[PLATE 4.]

The microscopic effects of stress on platinum do not appear to have been studied. An ingot of pure platinum was therefore prepared, and from this a portion was accurately machined in the form of a cube, 0·30 inch square, which was afterwards carefully microscopically polished, and then subjected to compressive stress in the testing machine.

Prior to the application of stress, and for comparative purposes, a polished face of the platinum cube was microscopically examined, but an even polished surface only was observed. A force producing a compression of 10 per cent. on the total height of the cube was then applied, and microscopic observations were taken at high magnifications of the effects of the stress on the micro-crystalline structure of the platinum cube. The particulars of the stress applied are given on Table I.

Table I.—Compressive Stress applied to Platinum Cube.

	Cross-section. Dimensions, inches.	Area. Square inches.	Height before test. Inches.	Stress required to compress sample 10 per cent. of its original height. Tons per square inch.
Platinum cube..	0·30 × 0·29	0·087	0·30	12·82

The polished side of the cube upon which the high-power microscopic examination was made was the one in line, or in parallel, with the direction of the compressive force. The results observed were very interesting, and confirm Professor Ewing's and Mr. Rosenhain's observations on the peculiar manner in which the crystalline structure of a mass of metal becomes altered when under stress.*

On comparing the appearance of the platinum after having been stressed with its appearance before the application of stress, it was found that many of the individual large or primary crystal grains forming the mass had, under the influence of the strain, developed innumerable fine “stress bands” or “slip bands,” or indications of crystalline slip. The main lines of disruption were noticed in many instances to roughly approximate to an angle of about 45° to the

* Bakerian Lecture, 1899, ‘Phil. Trans.,’ A, vol. 193, 1900, p. 353.

FIG. 1.



Microscopic Effects of Compression Stress on Platinum, showing Crystalline Slip, as seen in Section. Magnification 120 diameters. Vertical illumination. Metal compressed 10 per cent. Arrow indicates direction of compressive force.

FIG. 2.



Magnification 120 diameters.

FIG. 3.



Magnification 250 diameters.

Microscopic Effects of Compression Stress on Platinum, showing Crystalline Slip, as seen in Section. Vertical illumination. Metal compressed 10 per cent. Arrow indicates direction of compressive force.

line of the compressive force on the crystal sectional facets. Between these larger indications of crystalline slip were observed a number of extremely fine lines, indicative of the nature of the crystalline slip; many of these ran more or less in parallel lines in each individual primary crystal or crystal grain, the direction of the orientation (or line of the normal cleavage) of each primary crystal grain apparently influencing the direction of the "slip bands," as seen in section.

Owing to the varied orientation of the different crystals in the mass of the platinum,* the lines of cleavage as indicated by the minute "slip bands," were often seen at varied angles to the line of the straining force.

These experiments have also confirmed the observations of Professor Ewing and others, that stress alone, without etching, sometimes renders manifest the lines of intercrystalline junction of the large or primary crystal grains of a stressed metal, providing that the stress is of sufficient intensity. This will be seen on reference to the accompanying illustrations, Plate 4.

The general appearance of the disintegration of the large or primary crystal grains, produced by the pressure, on the pure platinum cube, was the apparent breaking up of the crystalline structure of the metallic mass, as seen in section, roughly diagonally to the line of the compressive force. The area enclosed by the main lines of disruption roughly approximating to the size of the large primary crystal grains. The distances between the extremely fine lines, or "slip bands," appeared roughly to coincide proportionately with the size of the secondary or most minute crystals forming the mass, the finer "slip bands" appearing to indicate the crystalline slip which had taken place along the facets of the smaller or secondary crystals. The direction, however, of the main lines of the crystalline disruption did not appear always to coincide with the intercrystalline facet junctions of the large or primary crystal grains. The lines of least resistance, or greatest crystalline slip, seemed chiefly to develop at an approximate angle of about 45 degrees to the pressure line, as previously mentioned; but the line of greatest weakness in the mass structure of the metal was not always at that angle with the line of the disruptive force.

The previous description generally and approximately indicates the effect observed, but the breaking up of the crystalline structure of the metal appeared to be subject to modifications according to varied internal or external conditions.

* See "Micro-crystalline Structure of Platinum," by Thomas Andrews, 'Roy. Soc. Proc.,' vol. 69, March 21, 1902, No. 457, p. 433; also "Microscopic Structure of Gold and Gold Alloys," by Thomas Andrews, 'Engineering,' September 30, October 28, December 9, 1898; also "Micro-metallography of Iron," by Thomas Andrews, 'Roy. Soc. Proc.,' vol. 58, 1895.

The authors hope that these experiments may prove of use in affording an indication of the comparative behaviour of this "*ἀριστοκρατία*" or noblest metal platinum, with the behaviour of the constructive metals, copper, nickel, iron and steel, when under the influence of stress; and the experiments have also shown that the microscopic influences of stress in the heavy metal platinum are analogous to those which have been observed in metals of lower specific gravity.

DESCRIPTION OF PLATE.

Fig. 1.—Microscopic Effects of Compression Stress on Platinum, showing Crystalline Slip, as seen in Section. Magnification 120 diameters. Vertical illumination. Metal compressed 10 per cent. Arrow indicates direction of compressive force.

Fig. 2.—Microscopic Effects of Compression Stress on Platinum, showing Crystalline Slip, as seen in Section. Magnification 120 diameters. Vertical illumination. Metal compressed 10 per cent. Arrow indicates direction of compressive force.

Fig. 3.—Same as fig. 2, but magnified 250 diameters.

"A Note on the Recrystallisation of Platinum." By WALTER ROSENHAIN, B.A. (Cantab.), B.C.E. (Melbourne). Communicated by Professor EWING, F.R.S. Received May 1,—Read May 15, 1902.

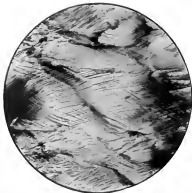
In a recent paper* Professor Ewing and the present author have described phenomena of recrystallisation in a number of metals, such as lead, tin, zinc, and cadmium, at temperatures well below the melting points of those metals. I have recently observed phenomena which appear to me to be of a very similar nature in the case of platinum.

It is a well-known fact that a prolonged exposure to a high temperature renders platinum brittle, and that the surface of such platinum, when it has been exposed to flame, shows markings "resembling the appearance of galvanised iron."† This phenomenon has generally been ascribed to the action of carbon, and by one author specifically to the action of acetylene.‡ Having studied the phenomena closely with the aid of the microscope, I do not find this view entirely confirmed.

In the first place, on examining the surface of the "changed" platinum with the microscope, it is seen to show a pattern which is

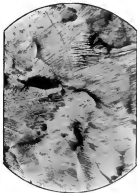
* "On the Crystalline Structure of Metals," second paper, 'Phil. Trans.,' A, 1900, vol. 195, pp. 279—301.

† "The Action of the Acetylene Flame on Platinum," J. J. Redwood, 'Soc. Chem. Industry Journ.,' vol. 17, p. 1107; also 'Zeitschrift für Analyt. Chem.,' 1901, heft 6, p. 411.



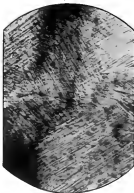
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